GIANT 2014 JAMBOREE

Judging Handbook

Part 1

A Guide to Judging at the iGEM Jamboree

Introduction from the Head Judging Committee

Welcome to iGEM and thank you for volunteering to judge our competition.

2014 is a big year for iGEM. To celebrate our 10th anniversary, we are hosting our first Giant Jamboree, our biggest Jamboree so far, and the biggest synbio event worldwide to date. We have 226 teams and over 2000 registered attendees, all of whom are coming to Boston to present their work.

We have worked hard to make judging better in 2014. For example, we have a new handbook to help you learn how to evaluate teams. We have also created a Responsible Conduct Committee (RCC) to address team or judge behavior complaints. Because this is the largest Jamboree we've ever had, we have more judges than ever before. With the help of software, we are making it easier to evaluate medals. Finally, we have new types of judges, each with a specific focus and expertise.

Judging in iGEM is complex and it can be hard to learn how to evaluate teams. We are addressing this problem by issuing the judging handbook in two parts. Our brand new first part is filled with case studies of great teams, winning teams, and examples of how iGEM rewards excellence. The judging committee has created a document with some examples of iGEM excellence, and how those projects won their respective awards. While there are certainly other examples of excellence in iGEM, these are our favorite. ¬¬
We have created the RCC to address cases of integrity, sportsmanship, honesty, respect, or judging violations in iGEM. Complaints can be reported to the RCC by anyone with a concern and a case will be opened. This committee exists for serious violations of the principles of iGEM and should be treated accordingly.

The Giant Jamboree is the largest event in the history of iGEM and also the history of synthetic biology. We have over one hundred judges to ensure teams are fairly and comprehensively evaluated. Because of the sheer number of people to manage at our event, we need judges to ensure they can complete their wiki evaluation assignments ahead of the event. We will also provide a forum for you to ask questions ahead of the event. There will be more open time at this Jamboree, but less time for individual discussions. We are relying on you to understand what you need to accomplish before coming to Boston.

The rubric has been improved this year to make judging medals easier. We will be working on this down to the wire, so expect more on the mechanics of how to perform your judging assignment in part 2 of the handbook.

Finally, There is a lot of excellence in iGEM. We can't possibly show you case studies of all the best projects in iGEM, as there is too much content. We have had over a thousand iGEM teams in our ten-year history. But one element of the competition has always remained the same: we seek to reward and celebrate excellence across all areas of iGEM.

Kim de Mora - Judging Coordinator
Beth Beason - Co-Head Judge
Janie Brennan - Co-Head Judge
Pete Carr - Director of Judging

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PROJECTS

What are the characteristics of the very best iGEM projects? What sets them apart?

A team that will win the iGEM Competition not only presents a successful and well-communicated project, but also embodies the goals and values of the iGEM Foundation itself – advancement of synthetic biology, impact, education, accomplishment, use of standard parts, and integration of policy and practices, to name a few.

A successful iGEM project includes the following components: a wiki, a poster, a presentation at the Jamboree, and, depending on the track, some sort of deliverable to be used by the community (e.g., DNA parts, software, an art installation, etc). Although great teams demonstrate excellence in all of these components, the very best teams go above and beyond, not only presenting a clear and powerful story, but also connecting their projects to the wider world through careful consideration of their project's consequences. Finally, it is important to note that iGEM is about education; projects should be motivated, researched, and carried out primarily by students.

These facets of success are reflected in the "Project" section of the rubric, which is one of the main determinants for choosing finalists:

1.- How impressive is this project?
2.- How creative or novel is the team's project?
3.- Did the project work?
4.- How much did the team accomplish?
5.- Is the project likely to have an impact?
6.- How well are engineering and design principles used?
7.- How thoughtful and thorough was the team's consideration of policy & practices?
8.- Did they do the project themselves?

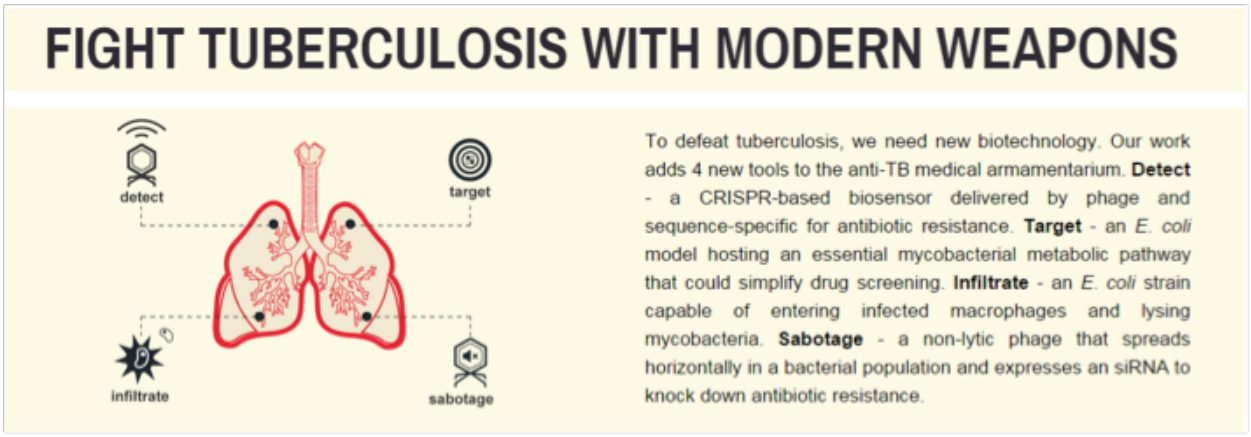
These aspects are the key iGEM values that apply to all teams, irrespective of track. New in 2014, we're introducing track-specific evaluation aspects that will help assess new track teams. These aspects have been introduced to reflect the changing nature of the competition and that not all new track teams are required to evaluate parts - a key part of all iGEM teams until now.

Winning teams don't necessarily need to score highly in every aspect; they create work that impresses the judges. Impressing the judges is what distinguishes winning teams from great teams. Using the rubric, judges can reward the best work according to how impressive it is, instead of according to a minimum set of criteria that teams need to meet. This difference is significant, as the scale and scope of work is not limited to "tick box" criteria that teams need to achieve, but by how much they can achieve in a given time.

To get a better idea of what judges recognize as exemplary, we will explore two projects:
Paris Bettencourt 2013 and **Calgary 2012**.

Case Study 1
Paris-Bettencourt 2013

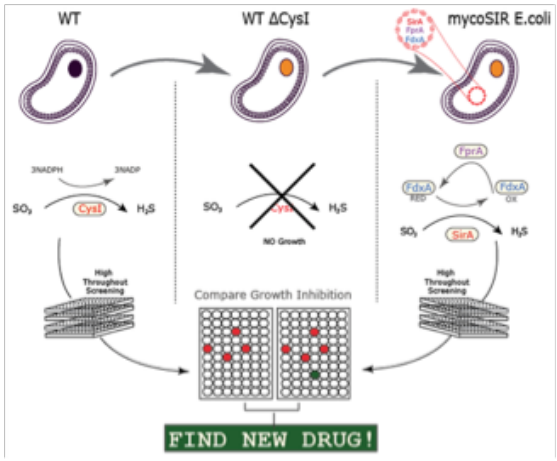
The 2013 grand prize winner Paris Bettencourt chose to tackle the worldwide problem of Tuberculosis (TB). In doing so, they took a holistic approach, seeking to eradicate TB through – not just one or two, but four – strikingly different strategies (see figure below):

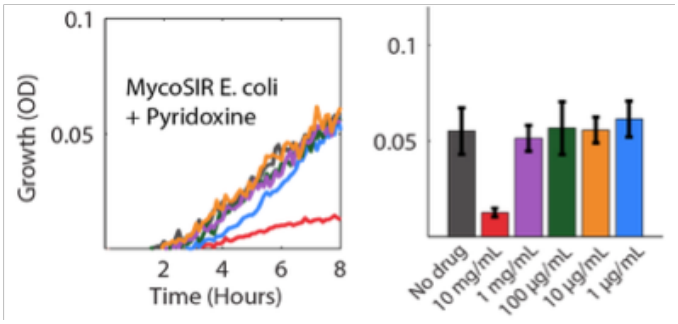


The project spanned a wide range of techniques – from traditional engineering of E. coli to CRISPR to phage systems to combinatorial drug screening. From this alone, we can tell that the team has done their research into TB; they seem to grasp the complexities of the situation and have decided that a multi-pronged approach is necessary. Aside from anything else, the creativity (rubric aspect 2) and ambition shown here is imzpressive (aspect 1).

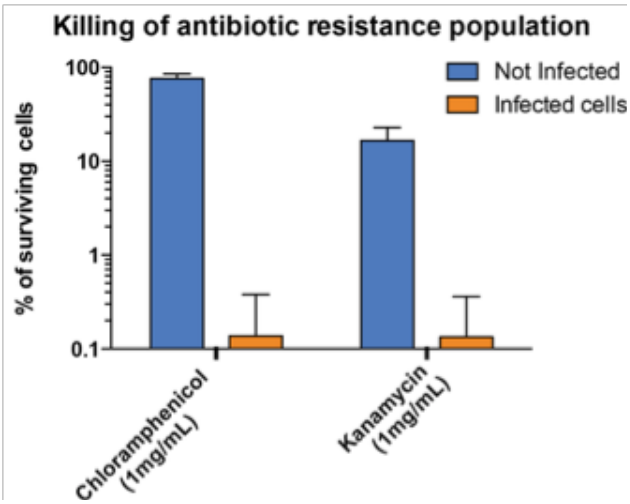
What is more impressive is that this project worked, and it did so on many levels (aspect 3). Let's look at two of their strategies: "Target" and "Sabotage".

For **"Target"**, the team designed a creative method for drug screening based on the sulfite reduction pathway (see figures below), part of the metabolism that is critical for TB function. They began by modeling the effects of this drug screening design on E. coli, and also created a script to identify potential metabolic targets for drugs that could be applied to other diseases. In doing so, they demonstrate excellent use of engineering and design principles (aspect 6), since their design is easy applied to other situations. The team then picked a target protein and found pyridoxine and riboflavin to be potential drug targets through extensive modeling. After cloning in their mycobacterial sulfite reduction pathway into E. coli, they found that pyridoxine would affect the mycobacterial pathway (and not the wild type E. coli pathway) at high doses. Working with the NIH, they received two drug libraries and screened them with their assay. They found ten potential drug candidates, several of which have structural similarities to pyridoxine. Not only did their targeting system work (aspect 3), but it is likely to have an impact (aspect 5), since no novel drugs have been found for TB in several decades.





Looking instead at the **"Sabotage"** strategy, Paris Bettencourt focused on taking down TB possessing multiple antibiotic resistances, as multiple antibiotic resistance is a significant problem for multiple disease types. They designed a low-burden phage delivery system for siRNA that would essentially knock out the antibiotic resistances of TB, keeping in mind and modeling possible effects of metabolic burden from their system (aspect 6). After applying their system, they efficiently killed over 99% of an antibiotic resistance-containing bacterial population (both chloramphenicol and kanamycin), demonstrating that their system worked (aspect 3). Taking their system further, they analyzed how any remaining bacteria were able to survive. The team determined that 70% of resistance to their knockout system resulted from a resistance to the siRNA itself. Even if their system is not entirely viable for clinical use, their system is designed such that a single PCR reaction can switch out the gene target for any target of interest, and could therefore be of great use to future iGEM teams (aspect 5).



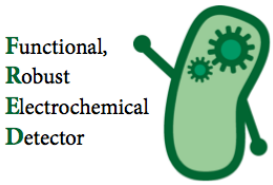
The 2013 Paris Bettencourt team was wildly successful on many fronts. The facets described here are only a brief look into the quality and breadth of the total project. Other notable features include a collaboration to report sensor development in iGEM and a study of gender equality in synthetic biology, which is even now influencing the organization and leadership within iGEM. Above everything, however, we should keep in mind that Paris Bettencourt impressed the judges (aspect 1). They did this through their creativity (2), the successful function of their well-designed systems (3, 6), the extent of their accomplishments (4), and the potential impact (5) of their work.

Their project exemplifies the ideals and goals of iGEM.

Case Study 2
Calgary 2012

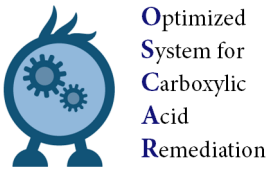
The team focused on bioremediation of tailing ponds, which are large bodies of water that accumulate toxic compounds as a byproduct of the oil extraction process in the oil sands of northern Alberta. They worked on two creative (aspect 2) projects, FRED and OSCAR (see figures below):

FRED



FRED stands for the Functional, Robust Electrochemical Detector, and he is one of our mascots for the 2012 iGEM Calgary project. FRED is involved in creating a biosensor that will work in environments where traditional biosensors will not, such as in turbid or anaerobic environments. This is important for oil sands applications such as in the tailings ponds where detection of toxins is needed but where the environments are murky and any samples taken from below a meter depth are low in oxygen. While there are traditional methods for detection of toxins, such as gas chromatography-mass spectrometry (GC-MS) or fourier transform infrared spectroscopy (FTIR), these techniques involve expensive machinery, skilled technicians, transport offsite and pre-processing before any data can be obtained. FRED will be able to do onsite testing in a matter of minutes with no advanced training required for users.

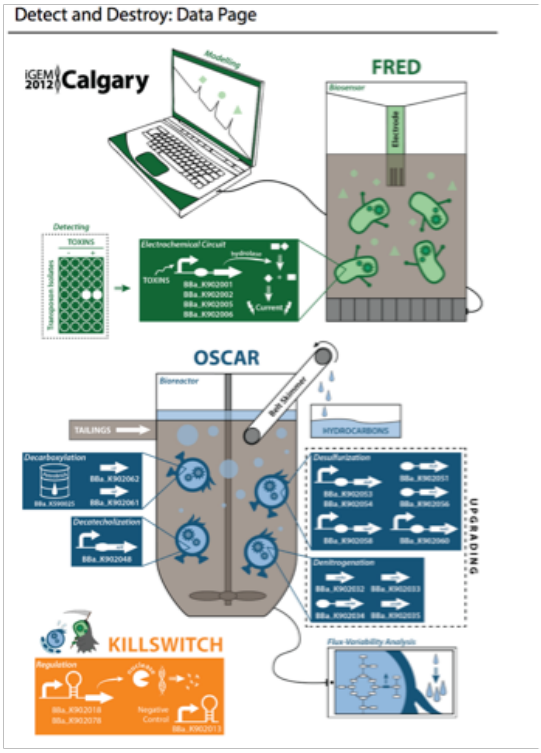
OSCAR



The Optimized System for Carboxylic Acid Remediation, or OSCAR, is the Destroy component to our iGEM 2012 Calgary project. With our detection system in place, OSCAR converts toxic compounds, such as naphthenic acids and catechol, into hydrocarbons by removing unwanted carboxylic acid and hydroxyl groups.

By conversion to hydrocarbons we can not only detoxify tailing waters but provide an economically viable method for doing so. By using flux balance analysis we developed a system to optimize the output of carboxylic acid removal system which we validated in the wetlab. Furthermore we developed a bioreactor prototype to demonstrate the applicability of our system using novel hydrocarbon collection methodologies. Finally, we developed constructs and genetic circuits to upgrade these hydrocarbons to reduce sulfur and nitrogen content. Altogether, OSCAR provides a method to upgrade naphthenic acids and other toxic components from waste products into useable fuels.

FRED involved creating a biosensor to work in turbid or anaerobic environments; this novel biosensor has potential to be of great value to the iGEM community as it will work in environments where traditional biosensors will not. The team accomplished a great deal (aspect 4) as evidenced by the number and type of parts that were submitted to the registry (see Calgary 2012 Parts). On the Detect and Destroy: Data Page, they show how the dual system works (see figure below) and summarize the parts they submitted or further characterized.



It's clear from Calgary's team members and attributions pages that they did the project themselves (aspect 8). They indicate which team members worked on which facets of the project and also describe additional support they received both inside and outside their home university. Additionally, this information is easy to find on their wiki.

The team's consideration of policy and practices (aspect 7) was "deeply integrated with the team's project and substantially addressed a broader concern." Calgary's human practices component drove the design of their project and provides an outstanding example for other teams. They participated in a dialogue about synthetic biology with the Oil Sands Leadership Initiative (OSLI) and conducted extensive interviews with leaders in oil sands reclamation in the early stages of project development as well as follow-up interviews with other experts to determine whether they had successfully addressed concerns from the first set of interviews. And they designed multiple layers of controls for FRED and OSCAR, including both physical (e.g., closed systems) and biological (an inducible ribo-killswitch system), to minimize the chance of releasing them into the environment.

Calgary clearly impressed the judges (aspect 1). At the Americas West Regional Jamboree in 2012, they were a regional finalist and were awarded Best Wiki, Best Poster, Best Model, Best Human Practices Advance, and a Safety Commendation. At the World Championship

Jamboree, they also won Best Human Practices Advance. Aside from being impressive, the Calgary 2012 team was worthy of commendation, as their project was done by students (aspect 8), was creative (2), accomplished a great deal (4), and thoughtfully and thoroughly considered policy and practices (7).

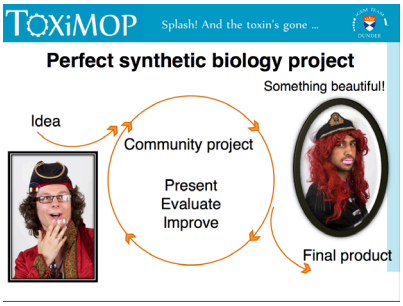
PRESENTATIONS

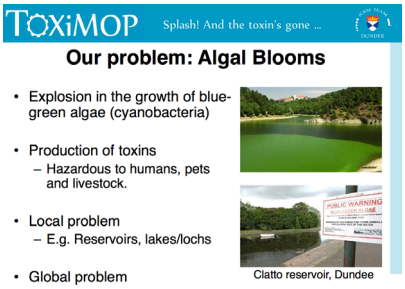
All iGEM teams must give a 20 minute presentation at the Jamboree about their project. Having a successful iGEM project goes beyond the project itself as teams should present their work in a clear and engaging manner and communicate their project to a broad audience. Above all, each team should tell a story as they present their work. In the 2014 iGEM rubric, there are 5 aspects for assessment that we should keep in mind as we evaluate presentations:

These facets of success are reflected in the “Project” section of the rubric, which is one of the main determinants for choosing finalists:

1.- Clarity of presentation: Could you follow the presentation flow?
2.- How good is graphic design? (layout, composition, grammar)
3.- Did you find the presentation engaging?
4.- Did they attribute the project correctly?
5.- How competent was the team at answering questions?

To explore an example of an outstanding team presentation, let’s take a look at the winner of the 2013 awards for Best Presentation, Europe, and Best Presentation, Undergrad (World Championship), Dundee. First, you should definitely watch Dundee’s video about targeting the toxin present in algal blooms:





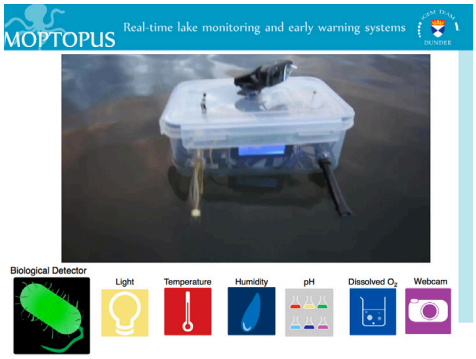
Their presentation is truly engaging and literally “kept me on the edge of my seat!” (aspect 3). Rather than separate each part of the project and have a team member talk about just that part, they told a story, connecting the different parts of the project. They began with an overview of their project and described how the public was included in the project from its start. Rather than sticking the policy & practices (formerly human practices) component at the end of their presentation, they weaved policy & practices into their story and addressed issues and concerVns throughout the presentation.

The presentation flowed (aspect 1) and led the audience to ask what’s next. The three presenters made smooth and effortless transitions during the presentation. Speakers maintained eye contact with good voice quality.

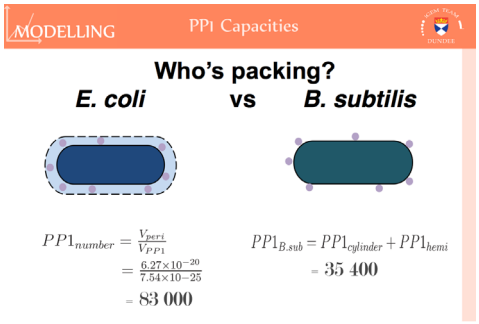
Their presentation style conveyed their excitement and enthusiasm for the project. Additionally, they introduced humor at timely and sometimes unexpected points during the presentation to keep the audience engaged (e.g., “How much wood can a woodchuck chuck…”). Also, it was clear that they practiced their talk, as their presentation was polished and professional. They even anticipated questions from the audience; they included extra slides at the end of their presentation, just in case (aspect 5).

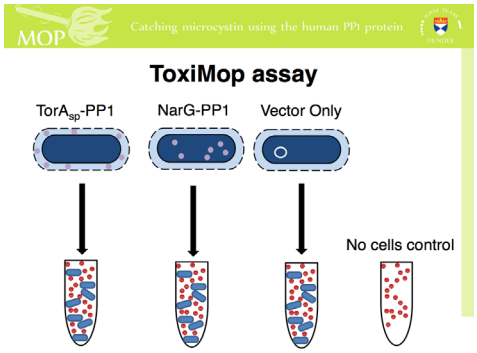
Now let's focus on graphic design (aspect 2) – an impressive presentation would be error-free and need no verbal guidance. What can we say about the slides used in Dundee's presentation? One thing that immediately stands out is that the slides are really clean! What does that mean? The slides had high overall appeal and delivered a clear message. Here are some characteristics of those slides:

Good quality and choice of images



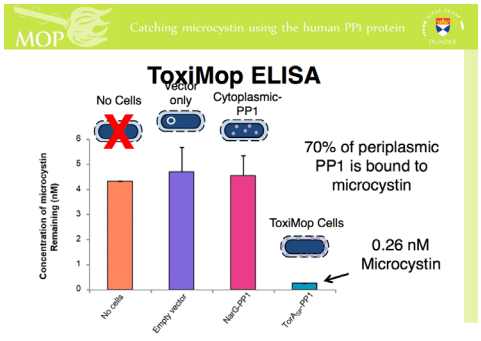
Lots of visuals (i.e., not too much text)

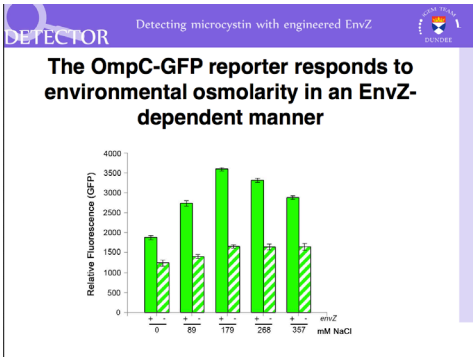




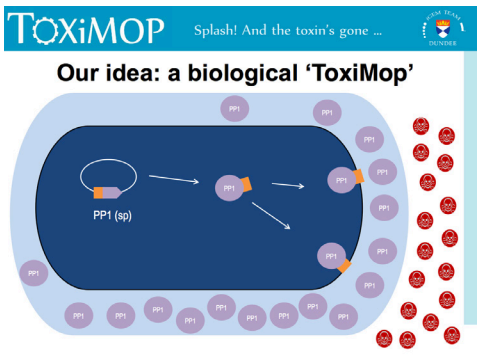
Appropriate size for font and images (i.e., slides were readable)

Well-labeled graphs with error bars

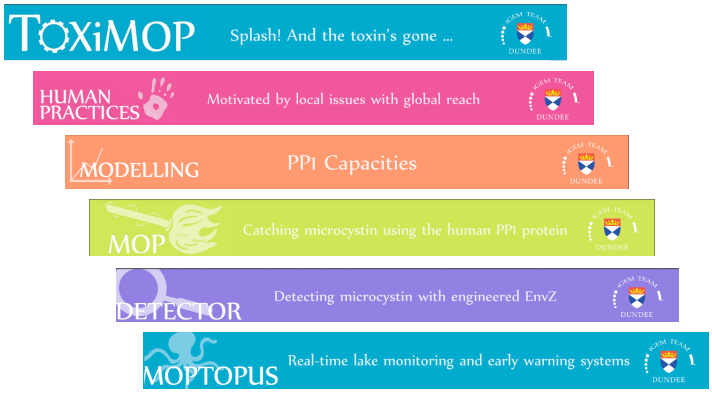




Meaningful animations (i.e., nothing too fancy or flashy)



Another characteristic of a good presentation concerns the use of color. It's important that the choice and use of colors are not distracting and contribute to the understanding. During the presentation, Dundee used colors effectively in the headers on the slides (see figure below). Each major part of their presentation had its own header to serve as a visual guide to the audience. Throughout the presentation, it was easy to see where the current slide fit into the overall project. This creative use of color with specific images and descriptive text greatly contributed to the clarity and flow in Dundee's presentation.



In summary, the Dundee 2013 presentation was recognized for its excellence in clarity (aspect 1), graphic design (2), and engagement of the audience (3).

WIKIS

In iGEM, the purpose of the team wiki is to publicly provide full project details to future teams and researchers in an organized, visually appealing manner. These details can and should include everything needed to reconstruct the project from the ground up, including the project goals, background information, research strategies, a lab notebook, experimental results, protocols, model documentation, results, safety information, BioBrick parts made, etc.

In terms of judging, the wiki is the very first thing a judge sees when assessing one of his or her assigned teams, as the wiki freeze occurs before the Jamboree begins. Characteristics like whether or not a wiki is informational, easy to navigate, or visually appealing can make a big impact on a team's critical first impression to the judging body. To explore an example of an excellent team wiki, let's take a look at the winner of the 2013 Undergrad Best Wiki award, SDU-Denmark

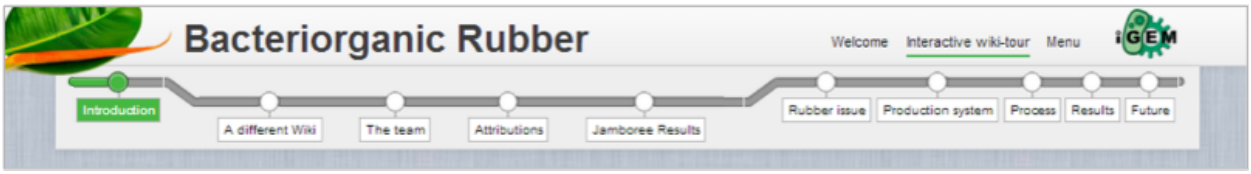
In the 2014 iGEM rubric, there are four aspects for wiki assessment that we should keep in mind as we explore the team's wiki.

1- Do I understand what they did and why?
2.- Is it attractive and easy to navigate?
3.- Are the data clearly connected to their accomplishments?
4.- Did they attribute the project correctly?

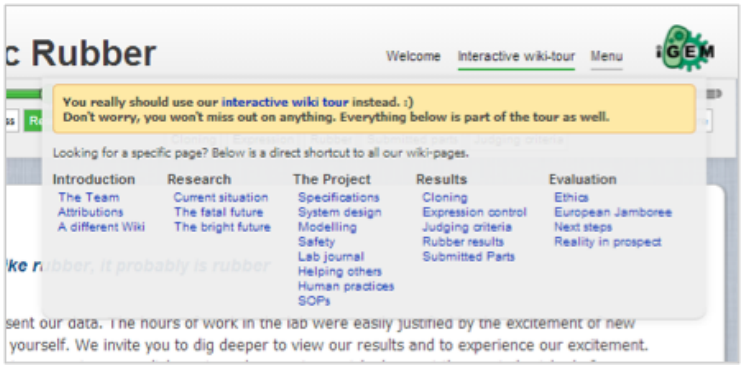
Looking at the front page for the SDU-Denmark wiki (shown below), we can see that the color scheme and layout is visually appealing (aspect 2). It is formatted in such a way that the eye is drawn to the critical information – in this case, the motivation and basic idea behind their project: making rubber using bacteria instead of trees.

We also see an invitation to join an interactive tour of their project. While this type of feature is not required and is not necessarily standard, it allows the team to tell their story in the most advantageous manner possible. If we start the tour, we are taken to the page below:

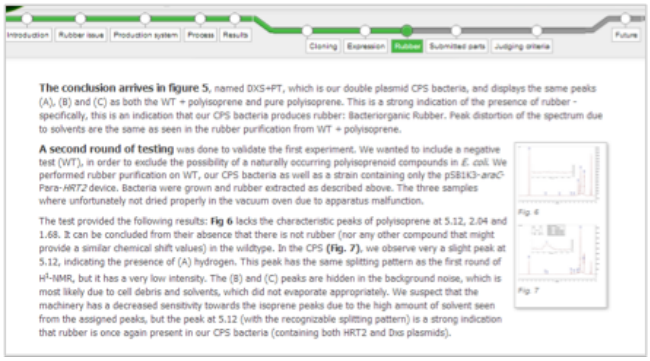
Following standard scientific writing, the team has begun their story with a summarized “abstract” of their project (aspect 1). At the top of the page, we can also clearly see a navigation track (aspect 2):

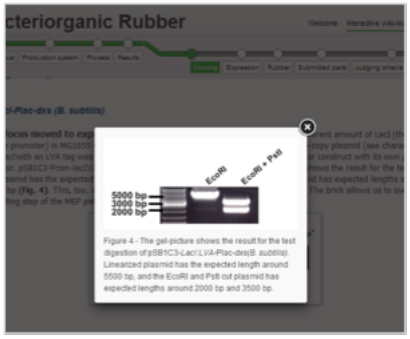


From the very beginning of their tour, SDU-Denmark has made it very easy for a judge to find the answers to aspects 3 and 4 regarding data and attributions (see the red arrows). However, for a viewer less interested in these Jamboree-specific questions, one can simply skip to the next chapter (“Rubber Issue”) that deals more with the story behind their project. Navigationally, this wiki also allows a viewer to easily jump to any particular section of interest by hovering over the “Menu” link:



The ease of navigation of this wiki (aspect 2) is just one characteristic that makes it deserving of the Best Wiki award. If we look more into the “guts” of the wiki, we find a wealth of information about the project, including in-line links to their references (reached by hovering over the speech bubble icons) (aspect 4). The information is laid out in a way that is visually easy to read and uses language that is easy to understand (aspects 1 and 2). In the results section, we find detailed descriptions of their entire experimental process, including dozens of publication-level figures that can be opened up in-screen for more detail (aspect 3):





Finally, it is important to note that this wiki also follows all of the iGEM wiki requirements (e.g., all pages, images, and files are hosted on the iGEM server, etc).

From the above, we can see why this wiki earned high marks in all four judging aspects. However, this wiki has some additional characteristics that facilitate judging for other categories in the rubric: (1) a page listing their accomplishments in terms of medal criteria and (2) direct links to their BioBricks in the Registry of Standard Biological Parts. Although these pages do not necessarily correspond to any of the four aspects for wiki assessment, they can be very useful to a judge before, during, and after a team's presentation when he or she is looking for the answers to specific judging questions. The availability and organization of the information reflects well on the team project as a whole. Finally, SDU-Denmark also makes their wiki source code available to all teams, demonstrating the sense of worldwide camaraderie and collaboration that is so important in iGEM

BASIC & COMPOSITE PARTS

BioBricks are the main building elements of iGEM that allow other teams to build on the shoulders of the previous teams. Since many teams incorporate basic parts into new devices, the impact of good BioBricks on the iGEM community can be seen years later. While a basic BioBrick part composes a single functional unit, a composite part is an integrated assembly of interchangeable components that can function with some versatility, linking its elementary functions (transcription, translation, encoded protein) together to give a higher order function (regulatory device). In the 2014 iGEM rubric, there are five aspects for assessment that we should keep in mind as we evaluate parts (with minor differences for basic and composite parts):

1.- Was it submitted according to the iGEM Registry Guidelines?
2.- Basic Parts: How does the documentation compare to BBa_K863006 and BBa_K863001?
Composite Parts: How does the documentation compare to BBa_K404122 and BBa_K863005?
3.- How new/innovative is it?
4.- Did the team show that it works as expected?
5.- Basic Parts: Is it compatible with Registry standards?
Composite Parts: Is it useful to the community?

This year, iGEM HQ hopes to streamline the process to determine whether or not a part has been submitted according to Registry guidelines – look for more information in Part 2 of the Judging Handbook! To satisfy Registry guidelines, the part must (1) arrive at iGEM HQ by the deadline (October 10th), (2) be in the pSB1C3 vector, (3) be BioBrick (RFC10) compatible or an agreed exception (on a case-by-case basis), (4) meet the standards set by the safety committee, and (5) be documented on the part page in the Registry.

Registry documentation should include:

- Basic description of the part
- Sequence and features
- Origin (organism)
- Experimental characterization
- Specific definition of the chassis and genetic context where it was demonstrated to work (and/or where it doesn't work)
- Potential applications
- Appropriate references from the primary literature

As a sample part evaluation, let's look at BBa_K863006, a basic part which contains the open reading frame for E. coli laccase and was created by the Bielefeld-Germany 2012 iGEM team.

As seen in aspect 2 of the rubric, this part is used to set an example for proper documentation of parts, most of which can be found on the part main page (see figures below). Not only is there a lengthy paragraph describing the basic biology behind the part and its main usage (with a literature reference), but also there is extensive data describing purification, SDS-PAGE, MALDI-TOF analysis, and enzyme activity assays for the E. coli laccase under the control of T7 promoter with a His-tag (see BBa_K863005 for additional information). Additionally, we can clearly see that this part is compatible with RFC10, as there is a green box labeled "10" next to "Assembly Compatibility" (see the red arrow). Therefore, this part also satisfies aspect 5 of the rubric for basic parts.

main page design experience information part tools edit

Part:BBa_K863006

Designed by: Isabel Huber Group: iGEM12_Bielefeld-Germany (2012-09-18)

Coding

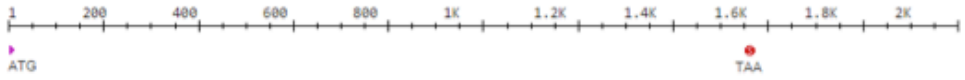
Released HQ 2013
Sample In stock
Experience: Works
Not Used
Get This Part

ecol laccase from E. coli

E.coli laccase ORF

Sequence and Features

Subparts | **Ruler** | SS | DS **Length: 1551 bp** View plasmid Get part sequence.



Assembly Compatibility: 10 12 21 23 25 1000

Usage and Biology

In the last few years a lot of attention has been drawn to laccases due to their ability to oxidize both phenolic and nonphenolic lignin related compounds as well as highly recalcitrant environmental pollutants. This makes them very useful for applications concerning several biotechnological processes. This includes the detoxification of industrial effluents, for example from the paper and pulp, textile and petrochemical industries. Laccases are also valuable as a tool as a tool for medical diagnostics and as a bioremediation agent to clean up herbicides, pesticides and certain explosives in soil. Furthermore these enzymes are also used as catalysts for the manufacture of anti-cancer drugs and even as ingredients in cosmetics[1]. Their capacity to remove xenobiotic substances and produce polymeric products makes them a useful tool for bioremediation purposes. In our project laccases are used as cleaning agents for a water purification system. Laccases are

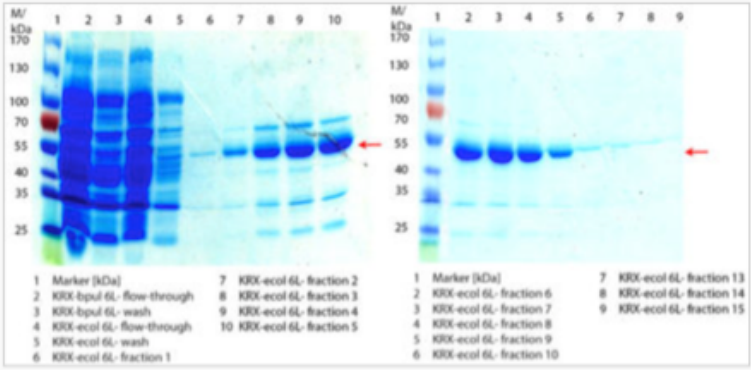


Figure 6: SDS-Pages of lysed *E. coli* KRX culture containing BBa_K863005 (fermented in a 6 L Bioengineering NFL22) after purification. The flow-through, wash and the elution fraction 1 to 15 are shown (except from fraction 11/12). The arrow marks the ECOL band with a molecular weight of 53.4 kDa.

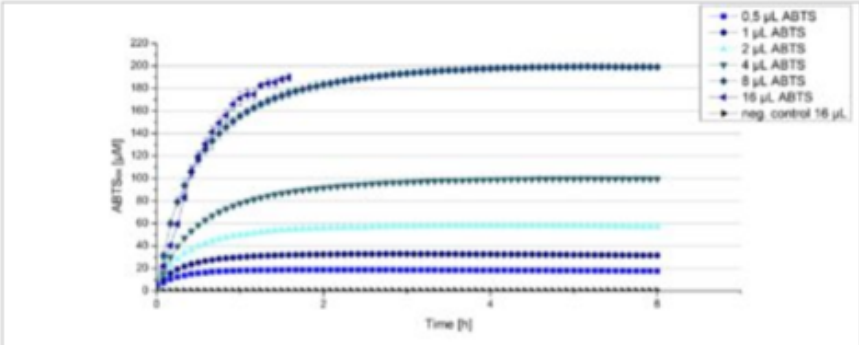
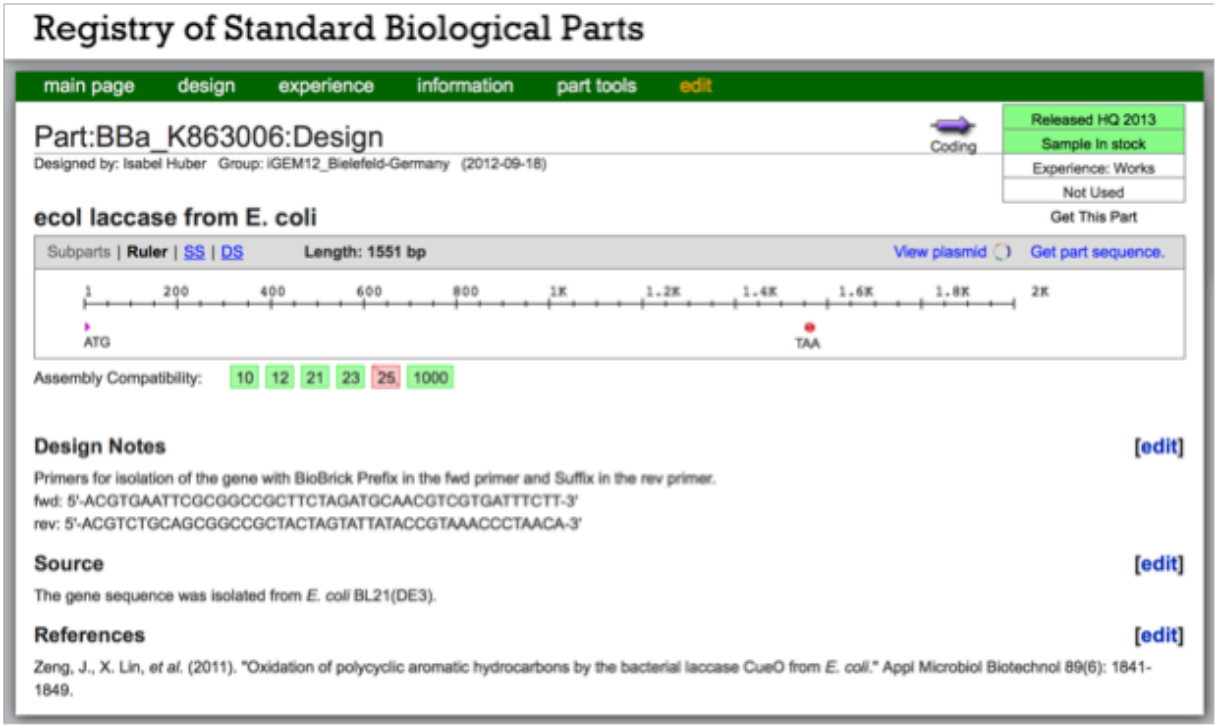


Figure 13: Analysis of ABTS oxidation by ECOL laccase tested with different amounts of ABTS. The higher the amount of ABTS the more oxidized ABTS can be detected.

On the design page, we additionally find information about the source of the part and the primers that were used to isolate the gene, allowing other researchers to replicate the work:



Another good example of a basic BioBrick part is BBa_K925000, which was created by the St. Andrews 2012 iGEM team and won the Best New BioBrick Part, Natural. This part is a coding sequence of a Delta-12 desaturase involved in Omega-3 biosynthetic pathway. Although the Registry documentation includes sequence information and some functional analysis, there are a few issues with the part that, if addressed, would greatly improve it's usefulness to the iGEM community:

- The part status box in the upper right-hand corner of the part page (see figure below) indicates that the part is unavailable, and it is unclear whether or not the part works.

- Since this part encodes only an enzyme, it must have been placed into some sort of device (containing a promoter, RBS, and terminator) in order to have been characterized. The part page does not specify the part number from which the characterization results were generated, nor does it state which promoter, RBS, etc., were used in lieu of referencing a separate part.

- There are no links to the wiki page of the project where we can read some other important details about part usage (including that the Part was transferred to the pET-Duet vector and used in E.coli strain BL21(DE3)).

- Since this part is derived from a natural source, it would have been useful if the team had also included a link to the UniProt sequence.

- Although there is a lot of experimental data on this page, the legends for the figures are not very detailed. In order to get the experimental details to understand the data, one is required to visit the team's wiki page. This is not ideal; instead, the Registry documentation should be able to stand alone.

For the most part, the process for judging basic and composite parts is identical. The only real difference lies in the fifth and final rubric aspect. For basic parts, the focus is on conforming to Registry standards, since the ability to integrate into standard cloning systems is directly related to the parts' usefulness. For composite parts, the focus is more directly on usefulness, since composite parts can often function as standalone devices and do not necessarily need to be integrated with other parts.

Let's take a quick look at some examples of great composite parts:

Our first example is BBa_K323135: VioA and VioB enzymes fused with zinc fingers under pBAD promoter. This part was created by the Slovenia 2010 iGEM team and won the award for Best New BioBrick Part or Device, Engineered. Aside from being quite well documented, this part worked, was well-documented, and had a useful, novel function. This part simply and effectively demonstrated how simple protein domains could be assembled into a higher order organization using a DNA-guided mechanism to put functions of interest into the correct location and orientation for efficient bioprocessing. This essential idea of DNA program-guided zinc fingers proved to be quite useful to the community. Not only did it open up the field of engineered subcellular-level localization and spatially-sequential processing, but it was adopted by later iGEM teams, including NCTU Formosa 2012, who incorporated the exact design into their project to improve fermentation of isobutanol.

A second example is BBa_K1150020: uniCAS Activator (CMV promoter). This part was created by the Freiburg 2013 iGEM team and won the award for Best New BioBrick Part/Device, Engineered in Europe. Again, this part had excellent documentation, conformed to RFC10, and had data demonstrating its working function. Even though CRISPR/Cas had already been popularized within the biology/bioengineering community, the uniCAS project brought this powerful tool into the iGEM community and provided a standardized collection of parts (exemplified by this part) which will likely serve as the foundations for other teams who wish to use the CRISPR/Cas system. In fact, the collection has already made its appearance in this year's "Featured Collection" in the Registry.

POLICY & PRACTICES

Human Practices has been an important component of iGEM since 2008. This year sees some exciting new developments to Human Practices: a name change – now Policy & Practices – and a dedicated Policy & Practices track, for teams wanting to do solely Policy & Practices work. We have also updated the judging rubric, and are developing a Policy & Practices wiki Hub to provide teams with more tips and guidance.

Policy & Practices (P&P) is now a mandatory activity for teams wishing to obtain a Silver or Gold medal, and we expect most teams to complete some P&P work. We welcome a wide variety of approaches within P&P – teams can pursue questions relating to regulatory, economic, ethical, social, legal, philosophical, ecological, security or other dimensions of synthetic biology. This typically means that we have a great variety of projects to judge!

The judging of a team's P&P performance is based on the descriptions they provide on their wiki and poster, and their discussion of P&P in their oral presentation and poster session. This document provides some suggestions on how to think about evaluating a team's P&P performance. Three key questions to keep in mind are:

- Has the team identified a clear and interesting question P&P to ask?
- Has the team adopted an appropriate method (or set of methods) for addressing their question(s)?
- Does the team articulate a clear connection between their P&P work and the more technical components of their project?

These questions are important because we want to know WHY an iGEM team has chosen their specific P&P activities, WHAT they have done, and HOW it links to the rest of their project. To make a good first impression, teams should be able to clearly and confidently discuss these facets of their P&P work in writing and in person.

More specifically, the 2014 iGEM rubric contains five aspects for evaluating Best Policy & Practices Advance. *These questions are new to the 2014 Jamboree.*

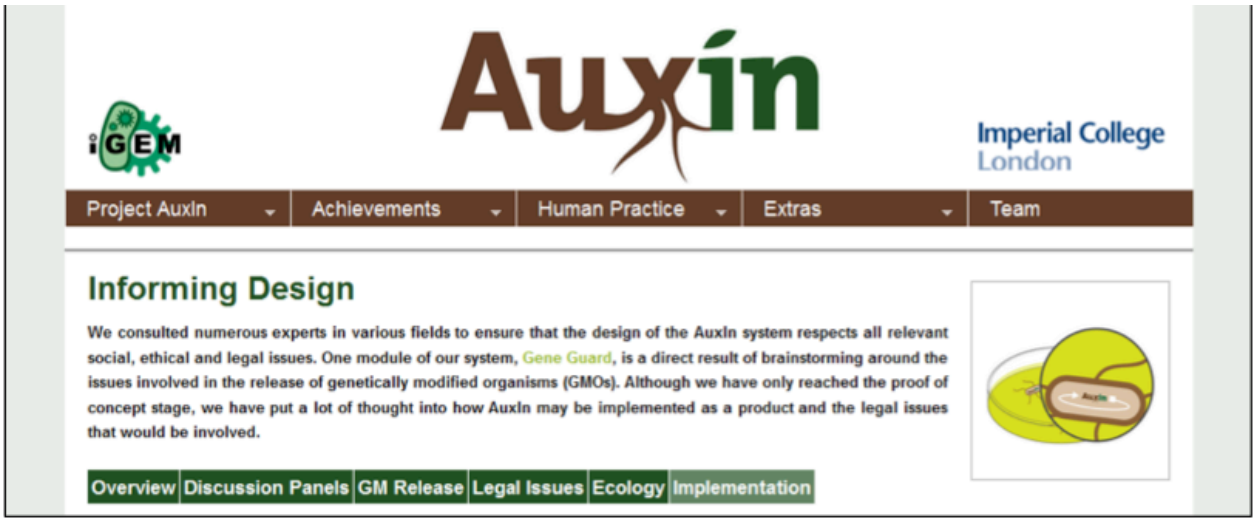
1.- Does the team's policy & practices work represent a novel contribution? (in methods or data or understanding of a topic)
2.- How well did the team articulate its P&P question(s), approach and findings?
3.- How much did the team accomplish through their P&P efforts?
4.- How well integrated with the broader project was the P&P work?
5.- Does the P&P project provide a good example for others?

The P&P committee has provided links to some excellent past projects on the P&P Hub: http://2014.igem.org/Policy_and_Practices#exemplars. It is important to note that in previous years, teams have not been asked to explicitly articulate a specific P&P question, and so have not been judged on exactly the same criteria listed above. But the overall approach of the exemplary projects we have identified captures the spirit of good P&P work.

To explore one example of an excellent Policy & Practices project, let's take a look at the winner of the 2011 Best Human Practices Advance, Imperial College London.

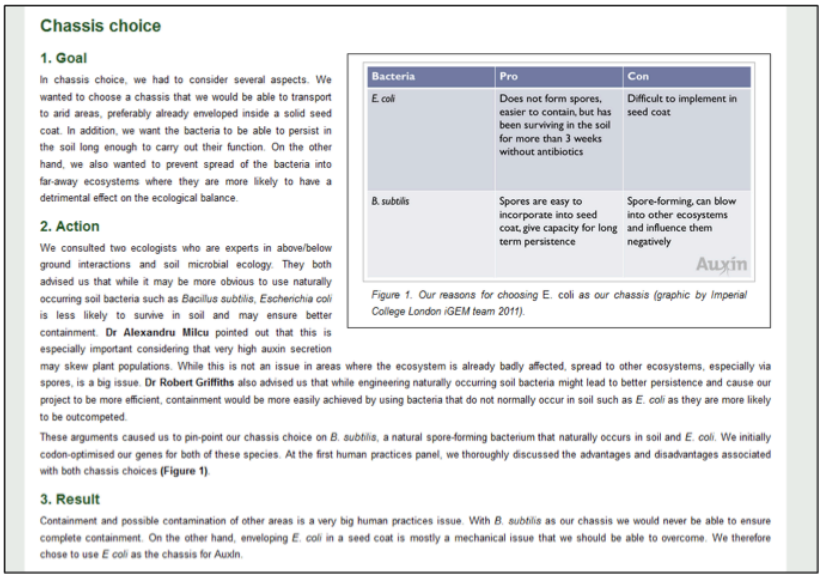
The 2011 Imperial team focused on P&P work that would inform the design and implementation of their overall project, which was about engineering bacteria to help fight soil erosion and desertification. Impressively, the team gave equal weighting to experimental work, modelling, and P&P.

The team was interested in scoping out a variety of ethical, legal and social issues that might specifically influence the design and implementation of their Auxin system (aspect 2). This is summarized nicely in the introductory paragraph to their P&P work:



To achieve this, they consulted with a range of stakeholders with different and relevant expertise, including companies, plant scientists and charities concerned with desertification (aspect 2). This is an appropriate method for the team to choose in the early design stages of a project, when you are trying to get a sense of key parameters, constraints and opportunities. By consulting experts based in different settings (academia, industry, NGO), the team is also able to incorporate multiple perspectives into the design of their system. The team provides nice clear summaries of these discussions, and includes photos of the event.

The team also outlines very clearly how these consultations influenced their further P&P activities, for example (i) the investigation of legal issues surrounding the release of genetically modified organisms, and (ii) the design of a 'Gene Guard' containment device with the aim of preventing horizontal gene transfer. Throughout their description of the Gene Guard, they make clear links between their understanding of the broader context of application and the technical design choices they were making. This is a nice example that shows how P&P work can inform aspects of the project's technical design in clear and appropriate ways (aspect 4).



Chassis choice

1. Goal

In chassis choice, we had to consider several aspects. We wanted to choose a chassis that we would be able to transport to arid areas, preferably already enveloped inside a solid seed coat. In addition, we want the bacteria to be able to persist in the soil long enough to carry out their function. On the other hand, we also wanted to prevent spread of the bacteria into far-away ecosystems where they are more likely to have a detrimental effect on the ecological balance.

Bacteria	Pro	Con
E. coli	Does not form spores, easier to contain, but has been surviving in the soil for more than 3 weeks without antibiotics	Difficult to implement in seed coat
B. subtilis	Spores are easy to incorporate into seed coat, give capacity for long term persistence	Spore-forming, can blow into other ecosystems and influence them negatively

Auxin

Figure 1. Our reasons for choosing E. coli as our chassis (graphic by Imperial College London iGEM team 2011).

2. Action

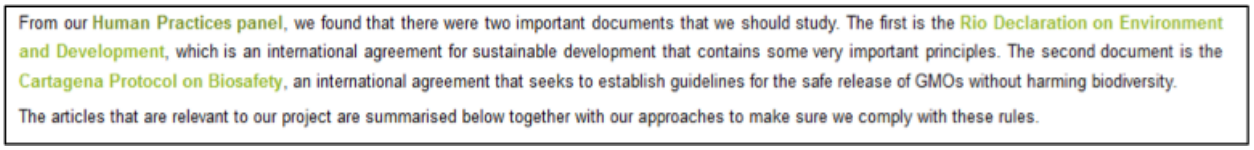
We consulted two ecologists who are experts in above/below ground interactions and soil microbial ecology. They both advised us that while it may be more obvious to use naturally occurring soil bacteria such as *Bacillus subtilis*, *Escherichia coli* is less likely to survive in soil and may ensure better containment. **Dr Alexandru Milcu** pointed out that this is especially important considering that very high auxin secretion may skew plant populations. While this is not an issue in areas where the ecosystem is already badly affected, spread to other ecosystems, especially via spores, is a big issue. **Dr Robert Griffiths** also advised us that while engineering naturally occurring soil bacteria might lead to better persistence and cause our project to be more efficient, containment would be more easily achieved by using bacteria that do not normally occur in soil such as *E. coli* as they are more likely to be outcompeted.

These arguments caused us to pin-point our chassis choice on *B. subtilis*, a natural spore-forming bacterium that naturally occurs in soil and *E. coli*. We initially codon-optimised our genes for both of these species. At the first human practices panel, we thoroughly discussed the advantages and disadvantages associated with both chassis choices **(Figure 1)**.

3. Result

Containment and possible contamination of other areas is a very big human practices issue. With *B. subtilis* as our chassis we would never be able to ensure complete containment. On the other hand, enveloping *E. coli* in a seed coat is mostly a mechanical issue that we should be able to overcome. We therefore chose to use *E coli* as the chassis for AuxIn.

In general, the P&P information is very clearly presented on the team's wiki, making it easy for judges to see what work they have done and why. The overall aim and description of the P&P work ('Informing Design') remains at the top of each wiki page relating to P&P, keeping a nice tight focus. Crucially, the team also does a good job of narrating their P&P work to help judges understand exactly how each P&P activity has influenced their thinking and actions regarding their project (aspect 2).



From our Human Practices panel, we found that there were two important documents that we should study. The first is the Rio Declaration on Environment and Development, which is an international agreement for sustainable development that contains some very important principles. The second document is the Cartagena Protocol on Biosafety, an international agreement that seeks to establish guidelines for the safe release of GMOs without harming biodiversity.

The articles that are relevant to our project are summarised below together with our approaches to make sure we comply with these rules.

Overall, the team did a significant amount of P&P work (aspect 3), exploring a wide range of legal, technical, and social questions relating to the potential implementation of their Auxin system, and consulting several relevant experts who could help inform different types of choices within their project design.

Importantly, the team was also aware of the limitations of their work, making it a nice example for others to pick up and build on (aspect 5). For example, they highlight up-front that this is proof-of-concept work, and they also note on their wiki that 'kill switches' are never 100% effective, and explain how their containment device is an attempt to improve on existing technologies (but is not a silver-bullet solution).

The team's approach to engaging with P&P topics throughout their project was encoded in a detailed implementation plan. While previous teams had experimented with various elements of this approach, the Imperial team's thoroughness, clarity, and combination of methods was considered by the judges to be a novel contribution to methods and understanding that could be adapted by other teams (aspect 1).

From the above, we can see why this P&P project earned a high score from the judges. The team did a lot of work, and importantly they did a great job at explaining what they did and why they did it, and what effect it had on their thinking as their project progressed.

MODELS

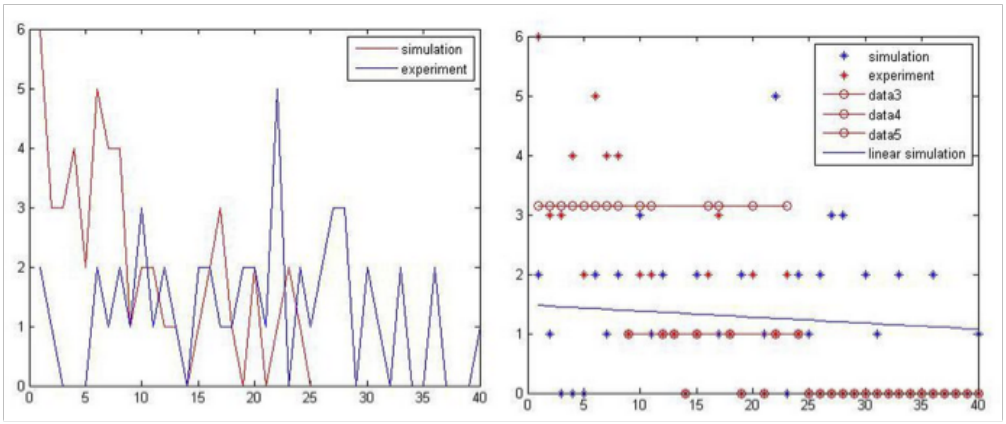
Many (but not all) teams will construct mathematical models to aid in the design, understanding, and implementation of their work. Often these are models associated with gene expression and protein function, but teams have also modeled cell behavior, and the behavior of systems or processes of which their engineered devices play a part.

In general, there is an emphasis on models that inform the design of parts or devices, based on real data, using modeling methods likely to be of use in the community.

Let's consider a few examples. Analysis of gene expression using systems of ordinary differential equations is not unusual in iGEM. Stochastic modeling of the same equations is less common, though by no means rare. While Colombia Uniandes 2013's approach was not unique, they distinguished themselves by careful consideration and research of their model parameters (see figure to the right) - citing each and lending credence to the veracity of their model. (In iGEM, as in life, one encounters many models composed almost entirely of educated guesses masquerading as parameters.)

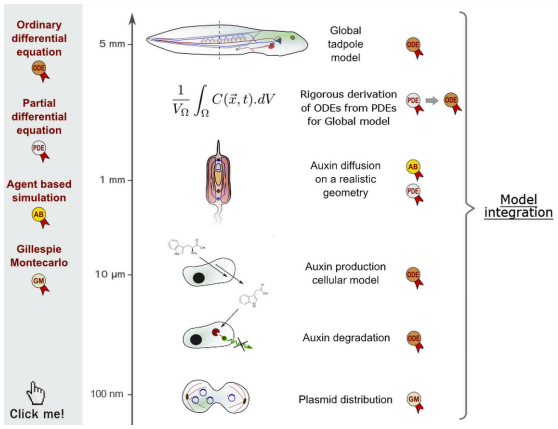
Team OUC-China 2013 performed a simulation of the behavior of bacteria with an artificial magnetic organelle in a magnetic field. Their physical model was novel, and noteworthy for its direct comparison to real data from their experiments in a microfluidic device. The model and the data were also used to generate a general equation for magnetobacteria behavior in a magnetic field (see graphs below).

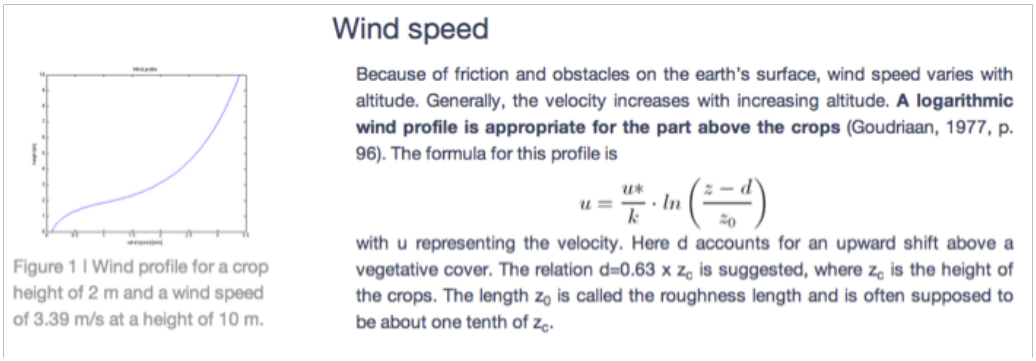
Parameter	Symbol	Value	Units	Notes	Source
Diffusion rate of Nickel	γ_N	0.5034	1/min		**Basurco et al.** "Evaluation of equilibrium, kinetic and thermodynamic parameters for biosorption of nickel (II) ions onto bacteria strain, Rhodococcus opacus" Minerals Engineering 22 (2009) 1318–1325
Dynamic constant for the entrance of nickel to the cell	k_p	4.63E-05	nM (nick)/(nM (HoxN)*min)	Original is 1 Apmol/(mg of protein*min). HoxN molecular weight is 33.1kDa. So we do the conversion. After 5 minutes the change od nickel is almost cero	**Wolfram, Lutz et al.** "The Alcaligenes eutrophus Protein HoxN Mediates Nickel Transport in *Escherichia coli*" Journal of Bacteriology. 1995 p. 1840-1843
Porine maximum expression rate	β	0.166	nM/ min		**Kalisky et al.** "Cost–benefit theory and optimal design of gene regulation functions", Phys. Biol. 4 (2007) 229–245, doi:10.1088/1478-3975/4/4/001 (A cell volume of 1 pL was assumed)
Association constant for DNA-RcnR complex	k_d	276	nM		**Iwig et al.** "DNA Recognition and Wrapping by Escherichia coli RcnR " J Am Chem Soc. 2009 August 19, 519.
Association constant of RcnR-Ni	k_x	21-29	nM		**Iwig et al.** "Ni (II) and Co(II) Sensing by *Escherichia coli* RcnR " J Am Chem Soc. 2008 June 18; 130(24): 7592–7606.
Repressor basal production rate	α_r	0.1	nM/min	Estimated order of magnitude	
Repressor destruction rate	δ_r	1/1200	1/min		**Staniland et. al.** "Cell division in magnetotactic bacteria splits magnetosome chain in half" Journal of Basic Microbiology. 2010 January 14: 50: 1-5
Rate constant for the formation of the tetramer	k_T	0.82		Needs to be found with the model	**Iwig et al.** "Ni(II) and Co(II) Sensing by Escherichia coli RcnR " One molecule of Nickel per monomer. The repressor is a tetramer. J Am Chem Soc. 2008 June 18; 130(24): 7592–7606.
Tetramer destruction rate	δ_T	1/1200	1/min		**Staniland et. al.** "Cell division in magnetotactic bacteria splits magnetosome chain in half" Journal of Basic Microbiology. 2010 January 14: 50: 1-5
Cooperation	n	1.5-4	N/A		**Iwig et al.** "Ni(II) and Co(II) Sensing by Escherichia coli RcnR " One molecule of Nickel per monomer. The repressor is a tetramer. J Am Chem Soc. 2008 June 18; 130(24): 7592–7606.
Porine basal production rate	α_P	3.3330	umol/min	It was considered that porine's production is lineal and that the division of an *E.coli* cell takes 1/2 hour	Nikaido, Hiroshi. Berkley University. Personal Communication. (2013, July 11).
Porine destruction rate	δ_P	1/1200	1/min		**Staniland et. al.** "Cell division in magnetotactic bacteria splits magnetosome chain in half" Journal of Basic Microbiology. 2010 January 14: 50: 1-5



Team Evry 2012 drew notice for generating a number of different models - using various techniques to model their system at a variety of length scales. This alone would have been impressive, but their work to integrate the various models - connecting them so that in the end measurable behavior could be modeled according to a series of interconnected models - was considered especially praiseworthy.

Likewise, KU Leuven 2013 used their model not only to describe what was happening on the order of a single cell, but also on the order of a colony - influencing their design and probing the robustness of the their oscillator. Perhaps more impressively, they also considered the functionality of their devices in the crop farming environment that they were designed for.





Wind speed

Figure 1 I Wind profile for a crop height of 2 m and a wind speed of 3.39 m/s at a height of 10 m.

Because of friction and obstacles on the earth's surface, wind speed varies with altitude. Generally, the velocity increases with increasing altitude. **A logarithmic wind profile is appropriate for the part above the crops** (Goudriaan, 1977, p. 96). The formula for this profile is

$$u = \frac{u*}{k} \cdot ln\left(\frac{z-d}{z_0}\right)$$

with u representing the velocity. Here d accounts for an upward shift above a vegetative cover. The relation d=0.63 x z_c is suggested, where z_c is the height of the crops. The length z_0 is called the roughness length and is often supposed to be about one tenth of z_c.

This model was used to determine the efficacy of their device and to better evaluate its potential impact.

In the iGEM 2014 rubric, there are four aspects for model assessment:

1.- How impressive is the mathematical modeling?
Is the model chosen and performed well, using measured parameters from the literature? Did they consider the sensitivity of the model to various parameters? Are their assumptions reasonable? Do you buy their interpretation of the results?

2.- Did the model help the team understand their device?
Did the team make design choices as a result of the model? Do they better understand the behavior of their device, or the impact that the device has on cells, cultures, the environment, etc.?

3.- Did the team use measurements of the device to develop the model?
Did the team build and test a modeled device, comparing these measured results to their model to either improve or validate it?

4.- Does the modeling approach provide a good example for others?
Would you suggest that future teams working on similar projects take a similar approach?

Let's consider these questions specifically as they relate to one of the examples: KU Leuven 2013.

1.- How impressive is the mathematical modeling?
KU Leuven performed flux balance analysis, solved for a system of ordinary differential equations (ODEs) searching through a reasonably broad parameter space, and considered physical convection of their pheromone product in a farming environment. They applied a wide variety of techniques to various aspects of their system, and did so very effectively. Their parameters come from the research and, when they are unknown, the team is up front about having estimated them (or searched a reasonable parameter space for them).

2.- Did the model help the team understand their device?
Their flux balance analysis was used to determine culture conditions to maximize production, while the ODE was used to consider synchronization of oscillating cells that begin out of phase. The models were not merely constructed; they were used to answer specific questions about the system.
The practical results of their convection model are less clear, because of the number of unknowns, but the team lets us know that they haven't measurements for many of these parameters, and uses the model instead as a "back of the envelope" exploration of the usability of the system.

3.- Did the team use measurements of the device to develop the model?
The results of their flux balance analysis were compared with experimental data gathered by the team**.**

4.- Does the modeling approach provide a good example for others?
Flux balance analysis and solving a system of ODEs are nothing new to iGEM, but this team did a remarkably thorough job of both, and took care to use these models to answer legitimate questions about their project (rather than throwing up a bunch of disconnected models; modeling for the sake of producing graphs).

POSTERS

In iGEM, the purpose of the poster is to communicate the project to others in a very concise, yet engaging manner. In the past, posters have been too “busy” and “unbalanced” in regards to text, figures, and space, forcing poster judges to look at other criteria when choosing the poster winners. We would like to turn things around this year by emphasizing the importance of balance and visual appeal in this form of scientific communication. In the 2014 iGEM rubric, there are six aspects for assessment that we should keep in mind as we evaluate posters:

1.- Clarity of poster: Do you understand what the team did and why?
Is the data clearly presented?
2.- Does the poster flow visually?
3.- How good is graphic design?
(is it neatly arranged, is the grammar correct, are key points clear)
4.- Is the data clearly presented?
5.- Did they attribute the project correctly?
6.- How competent was the team at answering questions?

The following details about poster format, poster components, poster evaluation criteria, and poster judging process are on the 2014 iGEM wiki (see poster judging guidelines).

Posters must conform to the following requirements (posters not conforming to these requirements will not be eligible for any special prizes):

- Maximum dimensions = 4 ft. X 4 ft. (1.219 m X 1.219 m)
- Font size must be readable from a distance. Recommended font sizes are:
    - o 44 pt for headers
    - o 38-40 pt for body text
    - o 18-24 pt for captions beneath figures
    - o 18 pt for references

Expected iGEM Poster Components

Poster judges will expect the following components to be present in some manner:

- Title
- Authors and their Affiliated Institution(s)
- Introduction
- Methodology
- Results/Conclusions
- Acknowledgments

Past iGEM teams have also elected to include additional components on their posters such as:

- Abstract
- Objectives
- Motivation
- Team Achievements
- Future Directions
- Human Practices
- Parts Submitted
- Funding Attributions (If Applicable)

In addition, some teams have elected to display supplemental materials at their poster station. These displays have included laptop/tablet presentations, team prepared pamphlets/handouts, and 3-D printed models. The supplemental materials will not be factored into the judging of the poster.

Poster Evaluation Criteria

The following criteria are used to evaluate the posters:

Ability to Stand Alone
The poster should be able to stand alone as a clear communication of the project without the team present.

Balance
The poster should be a balance of text, figures, and space. Excess text should be avoided - figures should play a dominant role in communicating the project on the poster. There should be adequate space around text and figures to avoid a crowded appearance. Judges will place heavy emphasis on balance.

Overall Visual Appeal
Color and font changes should be used appropriately. The use of too many colors creates an unprofessional appearance. Dramatic colors should be used only to illustrate dramatic points – overuse is simply confusing. There should be consistent use of color throughout the poster to represent the same concept - the colors should not be randomly switched. Due to red-green color-blindness, use of these colors to represent contrasting concepts should be avoided. A poster with overall visual appeal stands out among other posters.

Legibility
The poster should be easy to read. There should be high contrast between the text and background. The background should not be busy and distracting. The resolution of the printed poster should be high enough that the text is clear and there is sharp detail on the figures. Avoid use of poor quality micrographs and other images on the poster. Poster text and figures may appear clearer on screen than on paper; therefore, a printout of the poster should be viewed prior to display.

Quality of Graphics
The key concepts of the project should be diagrammatically represented. It is ideal if a single figure represents the entire concept. Figures should be well labeled and have clear legends. It should not be necessary for presenters to explain the figures.

Conciseness
The content of the poster should be technically written. It should take no longer than 10 minutes for someone to read the poster.

Flow
The poster content should follow a logical sequence. The reader should be able to navigate the poster with ease.

Appropriate and Relevant Content
Careful thought should be put into selection of poster content. Redundancy in the presentation of information becomes tedious and exists at the expense of other information.

Accuracy of Information Presented
The scientific content of the poster should be accurate. Models should be free of mathematical error. The poster reveals the STEM literacy of the team.

Grammar/Spelling
Posters should be critiqued before printing for spelling and grammar errors. Scientific names and mathematical units should be presented correctly.

Attributions
The poster is an opportunity to give credit to contributors who may not be present, and also to other scientists (e.g. earlier workers or competitors). Attribution should be for key concepts and not details (i.e. ~ 5 references but not 20).

Oral Presentation of Poster
The poster presentations provide judges the opportunity for detailed probing. The team should be able to answer in-depth questions. This is the opportunity for judges to find out if team members really understand the project.

Poster Judging Process

The posters will be critiqued by a team of poster judges prior to the poster reception. The posters will be judged at this time to ascertain if the posters can stand on their own as clear communication of the project. Presenters should not approach the judges during this time. During the poster reception, this team of judges will be visiting the posters and discussing the projects with team members. Evaluations of both the displayed poster and the oral presentation of the poster factor into the awarding of the Best Poster prize. Teams should be cognizant of the fact that judges involved in the awarding of iGEM medals and other prizes may utilize the poster reception as a resource for making decisions on those awards. In other words, all teams should strive to generate a high quality poster!

Judges have the following expectations of teams at the poster reception:

- Posters need to be set up for display by the deadline provided. Judges will be critiquing the posters before the poster reception commences.

• All team members should be present throughout the poster reception. Keep in mind that the team members have expertise in various components of the project. Inability of the team members who are present to correctly answer questions during the judges' visits negatively impacts the entire team, as well as its advisors and sponsors.

• Teams should not select a single spokesperson for the team, nor should a single team member monopolize the oral presentation of the poster to the judges. Judges expect a "team" presentation of the poster, so make certain that all team members are prepared to contribute if called upon.

• Other members of the iGEM community may be visiting your poster when a judge arrives at the team poster. Teams should inform other visitors that they will have to return later because a judge is now present. Judges should be given top priority during the poster reception because they have limited time to complete their judging responsibilities.

• Your oral presentation during the poster reception needs to be concise due to time constraints. If a judge requests a brief explanation, do not provide a lengthy one.

Let's look at two examples of winning posters. Macquarie Australia 2013 won the Best Poster, Asia, Overgrad. Their poster has high visual appeal and shows a good balance of figures and text with appropriate use of white space. The poster is fairly easy to read with contrast between the text and background and an appropriate choice of background. Most of the figures/images on the poster are high quality. The resolution of the Gibson Assembly diagram could be improved as it is a bit fuzzy as presented here. The font used to label the axes on the activity assay figures should be enlarged so it's clearer. Additionally, the figure legends need additional information to make this poster "stand alone." Appropriate and relevant content was selected and the flow of the poster is logical and easy to follow.

Heidelberg 2013 won Best Poster, Europe, Undergrad. This poster does a great job using color to guide the reader in navigating the poster—it's easy to tell which part of the poster goes with the summary in the center of the poster. The quality of the visuals is good and all of them contain labels; however, there are no clear figure legends and it's likely the team needed to be present to explain the poster. While there is a good balance of text and figures, the poster is heavy on methodology and consequently does not flow well.

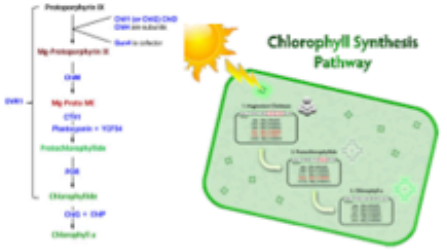
GREEN is the new BLACK

- In 2009 Australia relied on non-renewable energy from fossil fuels for 95% of its energy needs - 41% coal, 36% oil and 19% gas attributed to this. Successful production of chlorophyll in a bacterial host is the first step towards the synthetic construction of photosystem II, and the eventual creation of a new renewable energy source
- Our project aimed to express the thirteen genes (from *Chlamydomonas reinhardtii*) necessary for the chlorophyll biosynthesis pathway in a bacterial host (*Escherichia coli*)

Background

- Chlorophyll is the green pigment responsible for the absorption and transfer of light energy
- During photosynthesis, light energy is converted into chemical energy:

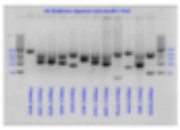
$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$



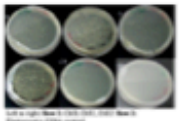
- *C. reinhardtii* is an algae that synthesises Chlorophyll a from protoporphyrin IX through a multistep pathway
- *E.coli* uses protoporphyrin IX in the production of heme
- A branch in the heme synthesis pathway will allow the use of *E. coli* as an expression host to create chlorophyll

Methodology

Results and Characterisation



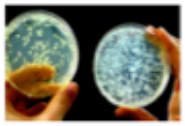
- **Gene Sequencing Results -** All of our genes were assembled correctly from gBlocks, all our sequencing results were submitted, and came back with an identity match of **100%**



- **Composite parts:** Tac promoter BBa_K864400 was successfully ligated with the genes: ChlD, ChlI1, ChlI2, Gun4, and Plastocyanin for further characterisation

ChlD activity assay:

- ChlD from the extract was used to form the magnesium chelatase complex with purified ChlI1, ChlI2, ChlH and GUN4 (Zhou *et al.* 2010 *FEBS letters* 586 (3), 205-210)
- The increasing fluorescence signal shows Mg-protoporphyrin formation indicating a complex containing functional ChlD has formed.
- 1µL of cell extract had 2.1ng of active ChlD protein



- **Plastocyanin:** chloroplast precursor - involved in electron transport
- Plastocyanin produces a copper chelated protein
- When exposed to an inducer and copper *E.coli* expressing this gene will turn blue (right plate)

Conclusion

- Successfully constructed 12 BioBricks
- Designed 3 operons necessary for chlorophyll biosynthesis
- Improved understanding on how to manipulate plant genes
- Initiated reproduction of photosystem II to act as a cheap and efficient renewable green energy source
- New sources of electrons and hydrogen gas to combat the energy crisis

Human Practices

Australasian Conference of Undergraduate Research
- Winner- Best Presentation in Molecular Biology or Plant Science research

Education
- Presented 2nd year uni lecture on synthetic biology
- High school synthetic biology workshops

Synthetic Biology Conference
- Organised first conference in Southern hemisphere

Synthetic Biology Society
- Initiators of SynBioNet Society

Quarantine
- Recommendations for easy access to information on international standards for shipping regulations

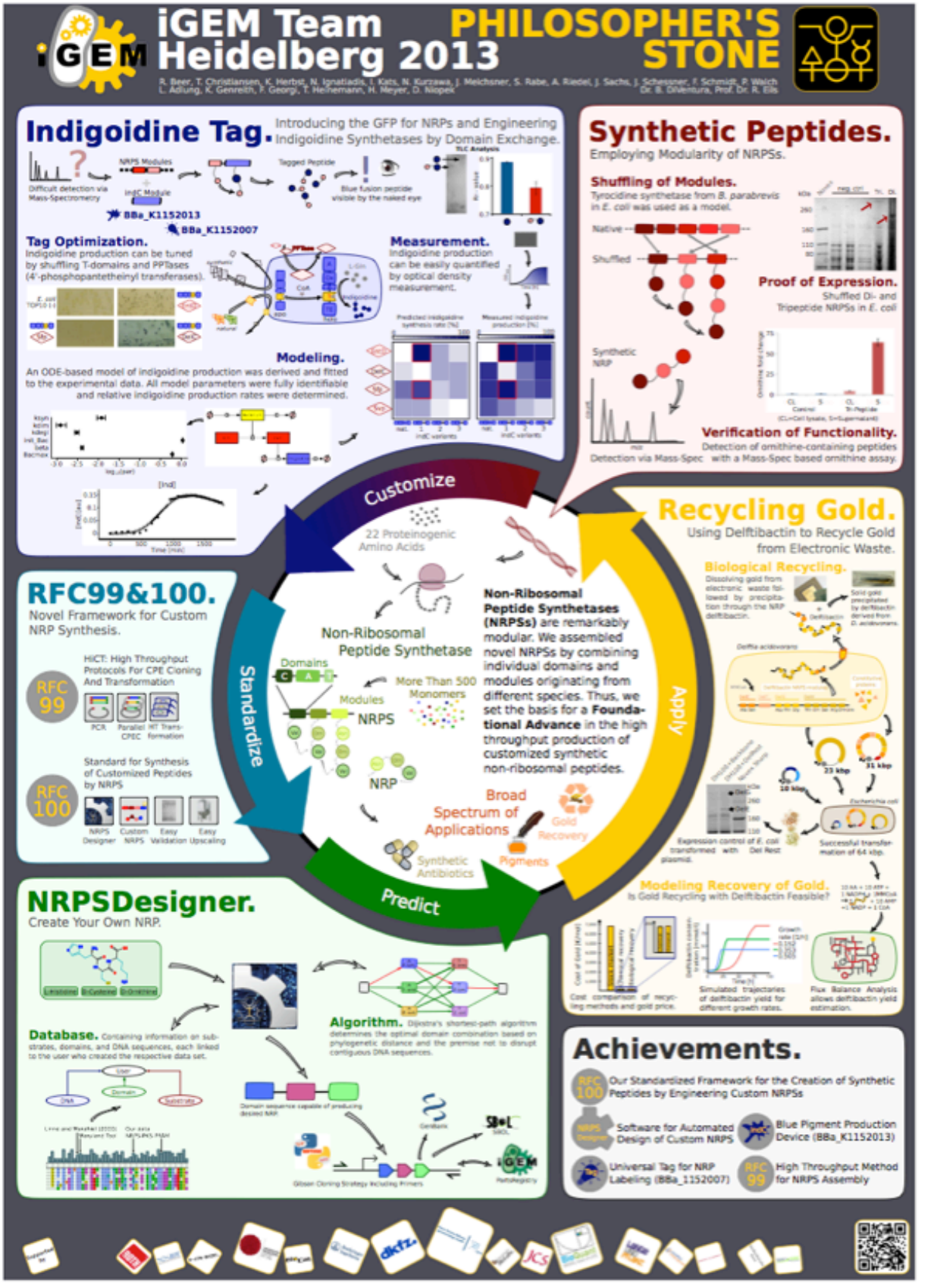
University Open Day
- Organised a variety of laboratory activities for members of the public

Collaboration With Sydney Uni iGEM
- Helped promote the Strange Nature writing competition
- Mentor program

MACQUARIE UNIVERSITY

M. Gibbs, D. Logel, M. Trouch, S. Chan, B. Brown, K. Gadsby, K. Blackshaw, A. Van Lierop, R. Sharma, H. Campbell, N. Dissanayake, A. Ryan, A. Mir, D. Russell, E. Cooper, D. Ubiparipovic, J. Phillips, D. McCarthy, C. Steel, A. Mala, F. Habl Almatin, A. Hammonds

IDT INTEGRATED DNA TECHNOLOGIES


iGEM Team Heidelberg 2013
PHILOSOPHER'S STONE
R. Beer, T. Christiansen, K. Herbst, N. Ignatiadis, I. Kats, N. Kurzawa, J. Melchsner, S. Rabe, A. Riedel, J. Sachs, J. Schessner, F. Schmidt, P. Walch
L. Adlung, K. Genreith, F. Georgi, T. Heinemann, H. Meyer, D. Niopek
Dr. B. Oliveritura, Prof. Dr. R. Ells
Indigoidine Tag.
Introducing the GFP for NRPs and Engineering Indigoidine Synthetases by Domain Exchange.
BBa_K1152013
BBa_K1152007
Tag Optimization.
Indigoidine production can be tuned by shuffling T-domains and PPTases (4'-phosphopantetheinyl transferases).
Measurement.
Indigoidine production can be easily quantified by optical density measurement.
Modeling.
An ODE-based model of indigoidine production was derived and fitted to the experimental data. All model parameters were fully identifiable and relative indigoidine production rates were determined.
Synthetic Peptides.
Employing Modularity of NRPSs.
Shuffling of Modules.
Tyrocidine synthetase from B. parabrevis in E. coli was used as a model.
Native
Shuffled
Proof of Expression.
Shuffled Di- and Tripeptide NRPSs in E. coli
Synthetic NRP
Detection via Mass-Spec
Verification of Functionality.
Detection of ornithine-containing peptides with a Mass-Spec based ornithine assay.
Customize
Standardize
Predict
Apply
22 Proteinogenic Amino Acids
Non-Ribosomal Peptide Synthetase
Domains
Modules
NRPS
More Than 500 Monomers
NRP
Non-Ribosomal Peptide Synthetases (NRPSs) are remarkably modular. We assembled novel NRPSs by combining individual domains and modules originating from different species. Thus, we set the basis for a Foundational Advance in the high throughput production of customized synthetic non-ribosomal peptides.
Broad Spectrum of Applications
Gold Recovery
Pigments
Synthetic Antibiotics
RFC99&100.
Novel Framework for Custom NRP Synthesis.
RFC 99
HiCT: High Throughput Protocols For CPE Cloning And Transformation
PCR
Parallel CPEC
HT Transformation
RFC 100
Standard for Synthesis of Customized Peptides by NRPS
NRPS Designer
Custom NRPS
Easy Validation
Easy Upscaling
Recycling Gold.
Using Delftibactin to Recycle Gold from Electronic Waste.
Biological Recycling.
Dissolving gold from electronic waste followed by precipitation through the NRP delftibactin.
Delftibactin
Delftia acidovorans
Expression control of E. coli transformed with Del Nest plasmid.
Successful transformation of 64 kbp.
Modeling Recovery of Gold.
Is Gold Recycling with Delftibactin Feasible?
Cost comparison of recycling methods and gold price.
Simulated trajectories of delftibactin yield for different growth rates.
Flux Balance Analysis allows delftibactin yield estimation.
NRPSDesigner.
Create Your Own NRP.
Database. Containing information on substrates, domains, and DNA sequences, each linked to the user who created the respective data set.
Algorithm. Dijkstra's shortest-path algorithm determines the optimal domain combination based on phylogenetic distance and the premise not to disrupt contiguous DNA sequences.
Achievements.
Our Standardized Framework for the Creation of Synthetic Peptides by Engineering Custom NRPSs
Software for Automated Design of Custom NRPS
Blue Pigment Production Device (BBa_K1152013)
Universal Tag for NRP Labeling (BBa_1152007)
High Throughput Method for NRPS Assembly

SOFTWARE

Software awards have been part of iGEM in different forms and shades since 2008. Nevertheless, there are quite a few changes compared to previous years, so we here try to illustrate our current priorities for judging software projects. In 2014, we put emphasis on encouraging teams (1) to create closer links to experimental work and (2) to avoid re-inventing the wheel and making their work more re-usable and useful for future developers. This has lead us to reformulate medal criteria and rubric questions. Before getting started, judges should (re-read) the 2014 Software Track Wiki page. This Wiki page was made available early on and it was the main guideline for teams over the summer.

Medal criteria, in particular, have been tightened. For example, the Silver criterium #4 -- “best practices in software development” -- may be, depending on how it is handled, pretty tough on young teams. Judges should keep this in mind and interpret these new criteria such that most teams still have a good chance of earning Silver or Gold medals.

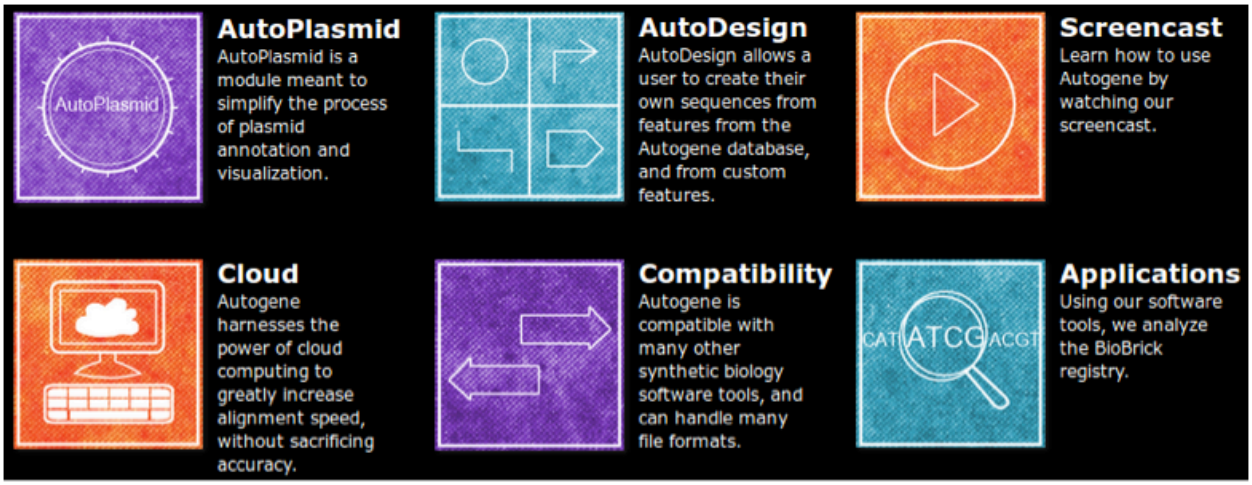
For the general ranking, including the possibility to win the Grand Prize, software teams are judged by the same 8 rubric aspects as everyone else -- starting from “How impressive was the project?” down to “Did they do the project themselves?”. Only aspects 9 and 10 are replaced by a more software-specific version:

9.- How useful is the software for bio-engineering?
10.- Is the software prepared to be extended and modified by other developers?

Software track judges then also have to answer 5 additional aspects to determine the winner of the Best Software Award:

1.- How well is the software using and supporting existing synthetic biology standards and platforms?
2.- Was this software validated by experimental work?
3.- Did the team use non-trivial algorithms or designs?
4.- How easily can others embed this software in new workflows?
5.- How user-friendly is the software?

We will now use the “Autogene” project from the Johns Hopkins Software team 2012 as an example. Autogene was the co-winner of the 2012 software track (together with the project from the UK Tokyo team). Let’s see why Autogene is a deserved winner and how it would fare with the new judging rules. The team has summarized the different components of their work on their Wiki:



The AutoPlasmid program is the core of the project. It allows users to automatically annotate a DNA sequence by matching it against a database of 40,000 known plasmid features. Features can then be collected into a “private registry” and used in AutoDesign to create new plasmids.
It is clear why judges liked this project: It addresses an unmet and very practical need and could, potentially, be very useful to almost every experimental synthetic biologists, thus answering general rubric aspect 5 (impact) and 9 (usefulness).

The programs are also very user friendly (software aspect 5) and the Wiki contains an easy step-by-step user guide with screenshots for all the important dialogs. Moreover, the team has used their software to check the annotations of some existing BioBricks and also analyzed the complete registry for the occurrence of pathogenic sequences. This application introduces Policy & Practice aspects (general aspect 7) and shows that the tool works (general aspect 3). This could also be interpreted as a rather successful validation of the software (earning perhaps 4 out of 5 points in software aspect 2), even though back in 2012, validation was not yet formally requested.

The team also did a good job at supporting existing standards (software aspect 1) by providing data import and export in four different formats (fasta, genbank, sbol, ApE). The parallelization of the Smith-Waterman alignment algorithm on an Autodesk cloud platform is certainly not a trivial design (software aspect 3) and is well documented on the Wiki. However, some critical questions (e.g. after the presentation) are in order: Why did they choose this particular platform? Could things have been sped up with more simple text matching methods?

This leaves us with general aspect 10 and software aspect 4 concerning how well this software can be embedded and extended or modified by other developers. This was not a judging criterium in 2012. However, both software winners of 2012 are a good example why we need to emphasize these aspects more. The source code of both projects is available on GitHub. However, in both cases, there are hardly any comments in the source code and very few comments are registered, meaning the history of code development is lost. The John Hopkins team provides neither documentation nor instructions for installation from source. Now, two years after the Jamboree, the link for downloading the program binary is broken (see figure below). Thus, there is a big barrier to use or further develop this very promising tool.

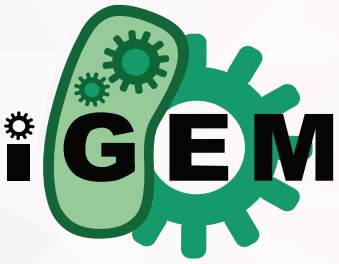
Meanwhile, the web server of the UT Tokyo team has also stopped working. Nevertheless, the team provides several useful README files. The README of their Biobrick_Search project, for example, contains a short description of each source file and sufficiently detailed step-by-step instructions for setting up a new copy of this web server.

This information is sufficient to get other developers started and may already encourage some to dig in and improve this software. More can be done, though — possible examples include automatic source code documentation, unit testing or well described test cases. We would now also like to encourage teams to provide programming interfaces (such as library API, ReST, or even simple command-line calls) so that future teams can integrate this software into their own workflows.

Judges, of course, should use their common sense to balance all these demands, new and old, against the limited time and experience available to our brave teams, and never forget to congratulate and encourage them for their great work and enthusiasm.

ACKNOWLEDGMENTS

We are excited to be able to present this document to the judges this year. However, it would not have been possible without the help of our contributors. In particular, we would like to thank the efforts of Martha Eborall, King Chow, Roman Jerala, Terry Johnson, Raik Grünberg, Emma Frow, Megan Palmer, and the rest of the P&P Committee.



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